



The Mole

Nothing, you dope! The Mole in Chemistry is a COUNTING UNIT! It was named in honor of Amedeo Avogadro, who discovered that no matter what type of gas there was, there was always the same number of MOLEcules present in the same volume.

The Mole is equal to:

$$6.02 \times 10^{23}$$

(Just like a dozen = 12)



So if a mole eats a dozen ants, he eats 12 ants. If a mole eats a mole of ants, he eats 6.02×10^{23} ants! A mole eating a mole of ants would be a FAT mole!

A mole of particles = 6.02×10^{23} particles

1 mole C = 6.02×10^{23} C atoms

1 mole H_2O = 6.02×10^{23} H_2O molecules

1 mole NaCl = 6.02×10^{23} formula units of NaCl



Yeah, like somebody I know...





How big is a mole, anyway?

A mole of Milk Bones...



Brainstorm for a mole analogy.

Then calculate exactly how big your analogy is.

Representative units for moles....



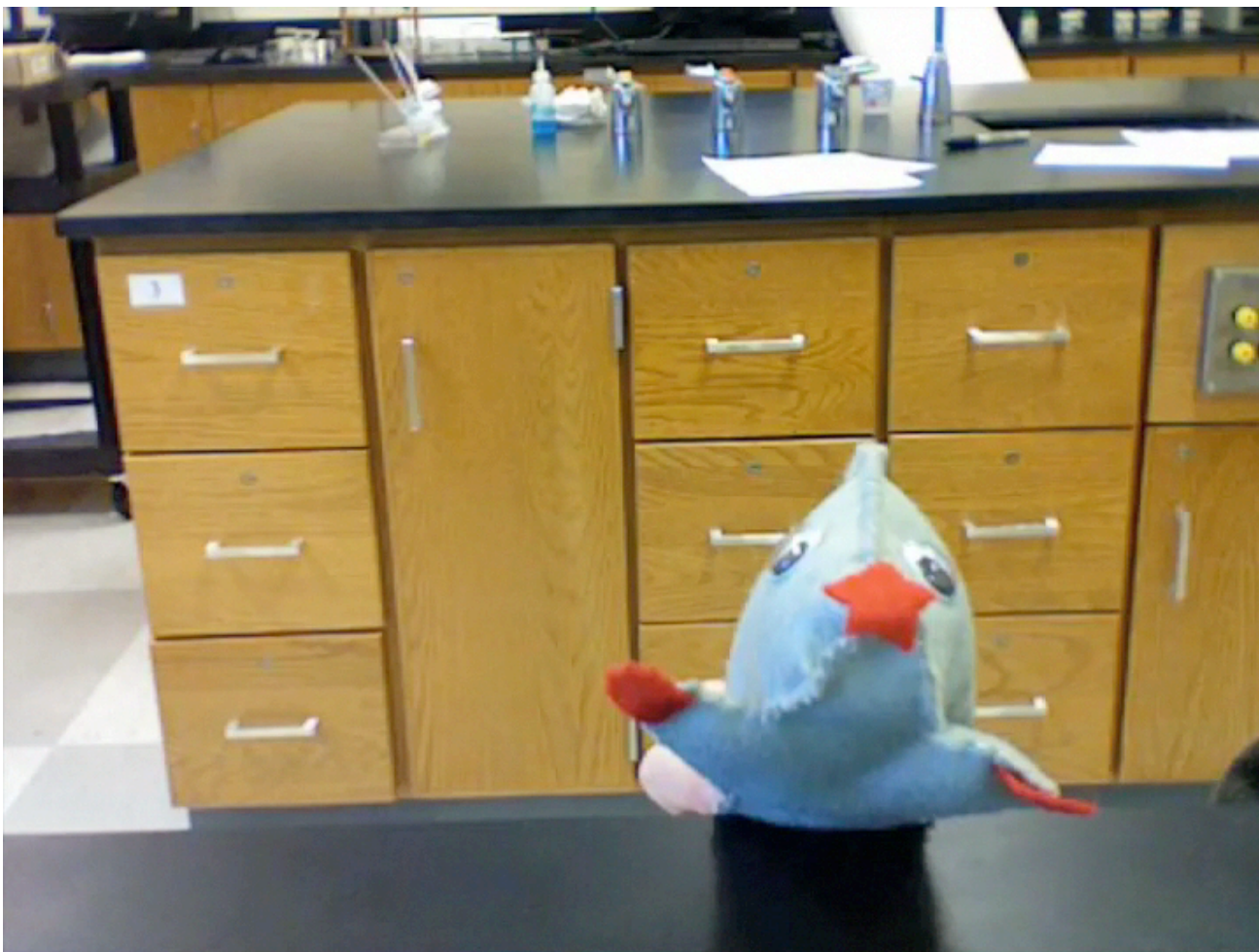
Element:

Atom

Cu

1 mole=

6.02×10^{23} atoms



Ionic
compound:

formula unit



1 mole=

$$6.02 \times 10^{23}$$

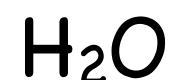
formula units

Remember, an ionic compound is made of a metal
+ a nonmetal.



Molecular
compound:

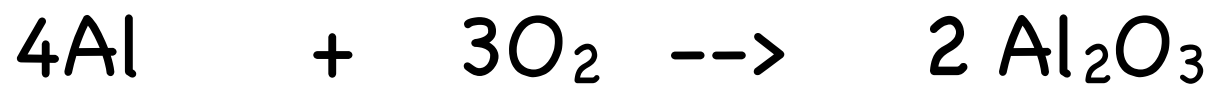
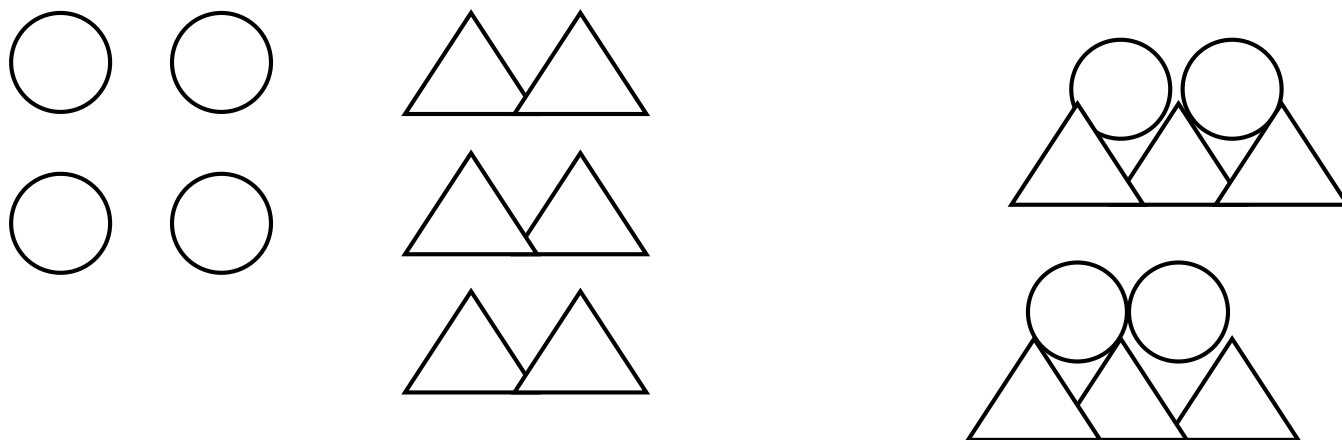
molecule



1 mole=
 6.02×10^{23}
molecules

Remember, a molecular compound is composed of
all nonmetals.

"4 moles of aluminum atoms + 3 moles of oxygen molecules yields 2 moles of aluminum oxide formula units.



moles of
substance

molar mass

moles of elements

atoms of
elements



- ④ This equation says: "4 moles of Al + 3 moles of O_2 yields 2 moles of Al_2O_3 "
- ④ If one mole = 6.02×10^{23} atoms, then I have a lot of counting to do, right?

How big is a mole?

Another analogy:

- ④ If you count to 6.02×10^{23} , one number per second, how long will it take?
- ④ $6.02 \times 10^{23} \times 1\text{min}/60\text{sec} \times 1\text{hr}/60\text{min} \times 1\text{day}/24\text{ hr} \times 1\text{ yr}/365\text{ days} =$
- ④ 1.9×10^{16} years = 19 quadrillion years!
- ④ The earth is 4.6 billion years old, so that's 4 million times the earth's age!

Can we really count that many atoms????

Well, let's see.....

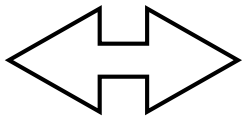
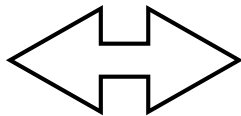


Counting to a mole.....

Mass of 1 mole = Atomic mass in
grams.

So, we can count moles BY
MEASURING MASS!

Moles are the link between counting atoms and
molecules and mass.

representative particles  MOLES  mass

The atomic mass in grams of any element is equal
to one mole (or 6.02×10^{23} atoms) of that
element!

How to find moles....

- The mass of 1 mole of any element is equal to the atomic mass of that element in grams.
- So, 1 mole of Al = 27.0 grams.
- And 4 moles of Al = $(4 \times 27.0) = 108$ grams.



What about 1 mole
of CaCO_3 ?

That equals:

$$\begin{aligned} & 1 \text{ mole of Ca} = 40.1 \text{ g} \\ + & 1 \text{ mole of C} = 12.0 \text{ g} \\ + & 3 \text{ moles of O} = (16.0 \times 3) \text{ g} \\ & = 48.0 \text{ g} \end{aligned}$$



ALUMINUM

1 Mole =

6.02×10^{23}



27.0 g



1 Mole =
 6.02×10^{23}
formula units



100.1 g



Mole joke

Molar Mass

④ Find the mass of 1 mole of:

④ Fe

④ Ti

④ SO_2

④ H_2O

Find the molar mass of:

1 mole of O_2

1 mole of $ZnCl_2$

1 mole of $PbSO_4$

Practice with molar mass

Find the molar mass of:



Conversion factors

Converting # of atoms to moles:

1 mol element \longleftrightarrow unit converting to
 6.02×10^{23} atoms \longleftrightarrow unit converting from

How many moles is 2.80×10^{24} atoms of Si?

How many moles is 2.17×10^{23} atoms of Br?

Remember, a conversion factor is a fraction:

Units converting to -->

Units we want

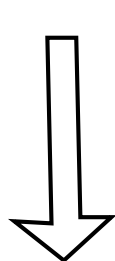
Units converting from --->

Units we want to get rid of

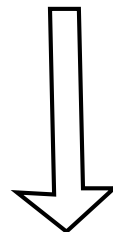


Converting moles to # of atoms

Conversion is: moles \rightarrow molecules \rightarrow atoms



$$\frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}}$$



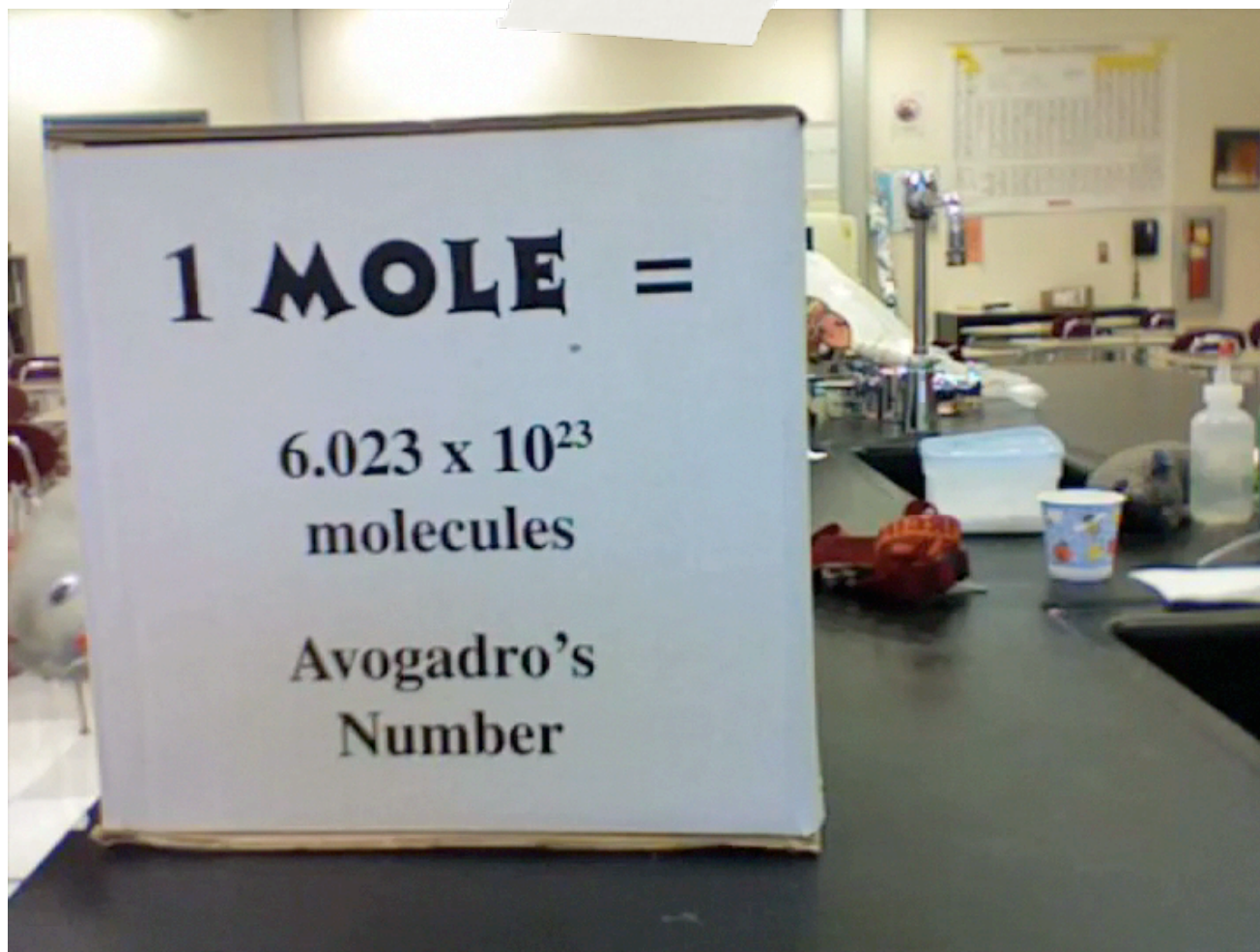
$$\frac{\# \text{ atoms in molecule}}{1 \text{ molecule}}$$

How many atoms are in 1.14 mol SO_2 ?

How many atoms are in 2.5 mol NO_2 ?

How many atoms are in 4.65 mol of NO_2 ?

What about moles of gases?



Molar Volume of a Gas

- 1 mole of any gas = 22.4L at STP
- What is STP? – Standard Temperature and Pressure
- = 0 degrees Celsius and 1 atmosphere pressure
- REMEMBER, 1 MOLE OF GAS = 22.4 L at STP

Practice with molar volume

1 mole of a gas at STP = 22.4 L volume.

To convert moles to volume, use the conversion factor $\frac{22.4\text{L gas}}{1\text{ mol gas}}$

a. What is the volume, in L, if 0.6 mol SO_2 at STP?

What is the volume of these gases at STP?

a. 3.7 mol N_2

b. 4.65 mol N_2

c. 0.335 mol C_2H_6

Volume to mole conversions

To go from molar volume to moles, use the conversion factor: $\frac{1 \text{ mol gas}}{22.4 \text{ L}}$

Find the number of moles of these volumes of gas:

a. 0.2 L H_2

b. 0.6 L CO_2

c. 2.5 L CH_4

Converting from moles to mass

What is the mass of 3.0 mol NaCl?

Find the molar mass of NaCl first: $23.0 \text{ g} + 35.5 \text{ g} = 58.5 \text{ g}$

Then convert:

$$3.0 \text{ mol NaCl} \times \frac{58.5 \text{ g}}{1 \text{ mol}} =$$

a. mass of 9.45 mol Al_2O_3 :

b. mass of 2.50 mol iron(II) hydroxide:

What is the conversion factor for converting grams to moles?

How many moles are in 465g SiO_2 ?

Thanks to all our moles for teaching us about moles...

